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Interference device for roughness measurement

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Summary

We proposed of interference method for measuring surface roughness. It is based on the RPS approach, which preassumes: i) infinitely extended object (all spatial frequency components of the radiation scattered by the object are present in registration zone); (ii) phase variance of the object is small; (iii) the correlation length of the inhomogeneity is larger than the wavelength.

A unique relationship is known to exist within this approach among the statistical parameters describing the object structure and associated correlation parameters of the scattered field.

The general schematic of the device is based on a shearing polarization interferometer. The relative displacement of the interferometer beams is set by the separation between the wedges, and the displacement of the movable wedge results in the alternating resulting intensity minima I_{min} and maxima I_{max} , which are recorded by the photodetector. The rms. height deviation R_q can be found from the relation

$$R_q = \frac{\lambda}{4\pi}\sqrt{-\ln\frac{I_{max}-I_{min}}{I_{max}+I_{min}}}.$$

The information contained in the resulting interference pattern is extracted by transforming the optical signals into electric ones, with their subsequent processing in the analogue electronic unit.

The device can by made either as a portable measuring head, or as a stationary instrument, depending on the size and the position of the object to be measured. The advantages of the device over those currently in use are its fast acting, high precision, non-contact nature of the measurement, and the possibility of averaging over a large number of roughness elements.

Therefore, in a shearing interferometer, the object field interferes with itself, rather than with the reference field, thus making possible the measurements of arbitrarily shaped surfaces with the radius of curvature larger than 0.2 m. This is especially important e.g. in the photochemical industry to monitor the quality of calender shafts, in the space industry to monitor the quality of mirrors fabricated by diamond micro-shapening etc. Being directly mounted at the polishing machine tool, this device was used for the surface quality control during making of the detail. Calender shafts and spherical mirrors under finishing of them by diamond micro-sharpening were controlled, and sensitivity on the rms height parameter down to 0,003 μ m was achieved

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Method of laser monitoring of oil pollution in sea water (in situ) using variable strobing, non-linear fluorimetry, and artificial neural networks techniques.

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The development of general-purpose practical methods of oil pollution (OP) monitoring in marine media still remains an actual task. Its importance is obvious in coastal marine water areas. At the same time, the difficulties of solving such problem grow dramatically for such water areas because of simultaneous influence of many factors that are insignificant for open sea waters. Information about OP concentration is extracted from the fluorescence spectrum under UV excitation. The main obstacle on the way to obtaining this information is wide fluorescence band of aquatic humic substance (AHS) and protein-like compounds.

It has been found out that at OP concentrations changes from units to tens of micrograms per liter, while typical for coastal waters AHS concentration is about 1 mg/l. In this case, the intensity of OP fluorescence band is significantly lower than the fluorescence intensity of AHS and protein-like substances. Generally, fluorescence bands of OP, AHS, and protein-like substances overlap. For this reason all known methods of OP determination in sea water are based on extraction by hexane and other solvents. We investigated the possibilities of OP determination in situ. The task is more complicated because of the effect of changing of OP fluorescence band parameters during its presence in water (the effect of "aging").

In this work, the outlined task is solved by means of method of artificial neural networks (ANN) in combination with the method of variable strobe (variant of TR fluorescence spectroscopy [1]) and non-linear fluorimetry [2]. As initial data for ANN training, the spectra obtained in different conditions were used: obtained for different OP in pure water and in water containing AHS at different concentrations, at different excitation wavelengths, at different times of the receiver strobe delay in respect to the laser pulse, at different photon flux densities of the exciting radiation. The results of this treatment of fluorescence spectra of real sea water samples from coastal waters of the Black Sea, model samples and computer simulations demonstrated real possibility of estimating the OP concentration in coastal water down to dozens of microgram per litre.

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